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(12) PATENT SPECIFICATION
ABSTRACT
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(54)	STRESS RELIEVING OIL BATH FOR MG AND/OR AL BASE ALLOY CASTINGS						
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(74)	HA						
(57)	CLAIM						

1. Application of products of the family of mineral oils characterized by the fact, that they are used as tempering baths for cast pieces of magnesium and/or aluminium alloys.
2. Tempering bath for pieces of magnesium and/or aluminium alloys characterized by the fact, that it consists essentially of mineral oil or a mixture of mineral oils for which the cooling rate is between 25 and 60 °C/s when measured at the centre of a cylinder having a diameter of 50 mm and a height of 63 mm, after having been plunged at 520°C into 12 litres of said oil or mixture of oils the temperature of which is close to 20°C, said cylinder being of a foundry alloy of aluminium base and containing the following components (apart from iron and other impurities)

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silicon	from 6.5 to 7.5%
magnesium	from 0.45 to 0.70%
titanium	from 0.15 to 0.35%

3. Tempering bath consisting of oil for tempering cast pieces of magnesium and/or aluminium alloys characterized by the fact, that the oil is a mineral oil or a mixture of mineral oils and is used at a temperature close to 20°C.

4. Method of tempering cast pieces of magnesium and/or aluminium alloys characterized by the fact, that a tempering bath consisting of a mineral oil, or mixture of mineral oils is used, said bath satisfying the conditions according to which the cooling rate at the end of the first phase of the tempering is between 25 and 60 °C/s, when measured at the centre of a cylinder specimen of 50 mm diameter and 63 mm height, after said cylinder has been plunged at 520 °C into 12 litres of said oil or mixture of oils having a temperature of about 20 °C, the cylinder being a foundry alloy of aluminium base containing, apart from iron and other impurities, 6,5 to 7,5 silicon, 0,45 to 0,70 magnesium and 0,15 to 0,35% titanium.

This invention relates to the composition of tempering baths for metal pieces and more particularly for the application of mineral oils forming tempering bath for cast pieces made from magnesium and/or aluminium alloys.

According to the present state of the Arts cast pieces of magnesium and/or aluminium alloys, in most cases, are cooled either on air, or in a water bath, both of which involve the disadvantage of causing strong internal tensions inside the pieces, tensions which can not be removed by annealing or tempering usually following the tempering process of metal pices.

It is known that the development of internal tensions inside the tempered pieces is due to a heterogeneous cooling of the piece, or to differences in cooling of the various zones of the pieces, said stresses are the more important, because the level of the average cooling speed is high and the disturbing phenomena, such as the presence of gas-pockets contacting certain zones of the tempered piece slow down the thermal exchange between the zones concerned and the tempering bath.

In general term, the curve representing the temperature inside the tempered piece as a function of the duration of tempering indicates that two phases follow each other and one can see that the internal stresses depend essentially on the speed of cooling in the first phase whereas the phenomena produced, as long as the mechanical characteristics are in direct relationship with the speed of the first cooling phase, start with the second phase.

The tempering bath will be the best should it produce good results in both phases, in other words, small

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internal stresses and good mechanical characteristics.

During the last years tempering baths used for tempering magnesium and/or aluminium alloy pieces consisted of solutions of water and glycol of inverse solubility, which means being more soluble at cold than at warm, with a glycol content of about 25%, said solutions have produced sensible progresses, the glycol forming a deposit on the surface of the piece during the first phase of cooling, its thin film offering the advantage of regulating the thermal exchange. Furthermore, certain concentrations of water-glycol offer the simultaneous advantage of conserving a good level of mechanical characteristics of the tempered pieces, a level which would have been achieved should water had been used as tempering medium.

However, results concerning internal stresses measured on several series of tempered pieces tempered under identical conditions indicate a dispersion which could not be reduced. Especially certain pieces of magnesium alloys produced limits of fatigue of 11 to 12 hectobars (hb), occasionally stresses of 10hb have been measured, whereas the normal values are between 2 and 4 hb.

The purpose of this invention is to provide a tempering bath for cast pieces of magnesium and/or aluminium alloys for all cases keeping the internal stresses at a low level and conserving the usual level of mechanical characteristics.

According to the invention the baths permitting to obtain such results are characterized in that they consist essentially of a mineral oil, or of a mixture of mineral oils for which a cooling rate of between 25 and 60 °C/s can

be reached at the end of the first phase of the tempering process when measured in the centre of a cylinder of 50 mm diameter and 63 mm height tempered at 520°C in 12 litres of oil or oil mixture the temperature of which is 20°C, the cylinder made from a foundry alloy on aluminium base and having the following composition by weight (apart from iron and other impurities.)

silicon	from 6.5 to 7.5%
magnesium	from 0.45 to 0.70%
titanium	from 0.15 to 0.35%.

As far as the application of the family of mineral oils for tempering baths for cast pieces of magnesium and/or aluminium alloys is concerned, the selection of mineral oils present a unique aptitude for such application as proved by tests done on the material in question the results of which are shown on the drawing attached hereto, Figure 1 representing the axial section of the metal cylinder used in the tests, whereas Figure 2 represents the curve of the cooling as measured at the centre of the cylinder as function of the time of cooling it.

Referring to Figure 1 cylinder 1 of 50 mm diameter and 63 mm height has been used, the composition of it was a foundry alloy on aluminium base having 6.5 to 7.5% by weight of silicon, 0.45 to 0.70% by weight of magnesium, 0.15 to 0.35% by weight of titanium, the amount of iron does not exceed 0.20%, whereas the other impurities, such as zinc, magnesium and copper do not exceed 0.10%, such an alloy is known in France under the designation AS7G06. In this cylinder 1 there is a first axial drilling 2 of 10 mm diameter and 10 mm depth, than a second drilling 3 at the bottom of the first one, the second having a diameter of 1.7 mm

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and a depth of 21 mm, in these drillings are body 4 and probe 5 of a thermocouple, for example a thermocouple connecting a wire of chromel with a wire of alumel. The cylinder 1, apart from being equipped with the thermocouple and with probe 5 these two are placed practically in the centre of the cylinder which is heated up to 520°C and then tempered in a bath of 12 litres of oil having a temperature of 20°C.

Should the curve of cooling measured at the centre of cylinder 1 (see Figure 2) indicate that the cooling rate at "A", at the end of the first phase of tempering is between 25 and 60°C/s, preferably in the vicinity of 40°C/s, the mineral oil could be used as tempering bath for pieces of magnesium and/or aluminium alloys, the extent of the usual internal stresses in the pieces, obtained when different tempering liquids have been used, are well known and are within 2 hb on traction and 3hb on compression, no values were outside this range, this statistic has been compiled from several dozens of pieces during a long period of time, whereas whenever water-glycol mixture has been applied as tempering bath occasional tests on identical pieces produced internal stresses of 10 hb on traction for aluminium or magnesium alloys having a fatigue limit of 11 to 12 hb, such high stresses explain the occurrence of fatigue cracks during the utilization of the pieces tempered in that manner.

The invention provides tempering bath of good quality, suitable for producing pieces of magnesium and/or aluminium alloys with low level internal stresses, while conserving the usual level of their mechanical characteristics.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Application of products of the family of mineral oils characterized by the fact, that they are used as tempering baths for cast pieces of magnesium and/or aluminium alloys.
2. Tempering bath for pieces of magnesium and/or aluminium alloys characterized by the fact, that it consists essentially of mineral oil or a mixture of mineral oils for which the cooling rate is between 25 and 60 °C/s when measured at the centre of a cylinder having a diameter of 50 mm and a height of 63 mm, after having been plunged at 520°C into 12 litres of said oil or mixture of oils the temperature of which is close to 20°C, said cylinder being of a foundry alloy of alluminium base and containing the following components (apart from iron and other impurities)

silicon	from 6.5 to 7.5%
magnesium	from 0.45 to 0.70%
titanium	from 0.15 to 0.35%

3. Tempering bath consisting of oil for tempering cast pieces of magnesium and/or aluminium alloys characterized by the fact, that the oil is a mineral oil or a mixture of mineral oils and is used at a temperature close to 20°C.

4. Method of tempering cast pieces of magnesium and/or aluminium alloys characterized by the fact, that a tempering bath consisting of a mineral oil, or mixture of mineral oils is used, said bath satisfying the conditions according to which the cooling rate at the end of the first phase of the tempering is between 25 and 60 °C/s, when measured at the centre of a cylinder specimen of 50 mm diameter and 63 mm height, after said cylinder has been plunged at 520 °C into 12 litres of said oil or mixture of oils having a temperature

of about 20 °C, the cylinder being a foundry alloy of aluminium base containing, apart from iron and other impurities, 6,5 to 7,5 silicon, 0,45 to 0,70 magnesium and 0,15 to 0,35% titanium.

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By Its Patent Attorneys

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Fellows Institute of Patent
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FIG 2

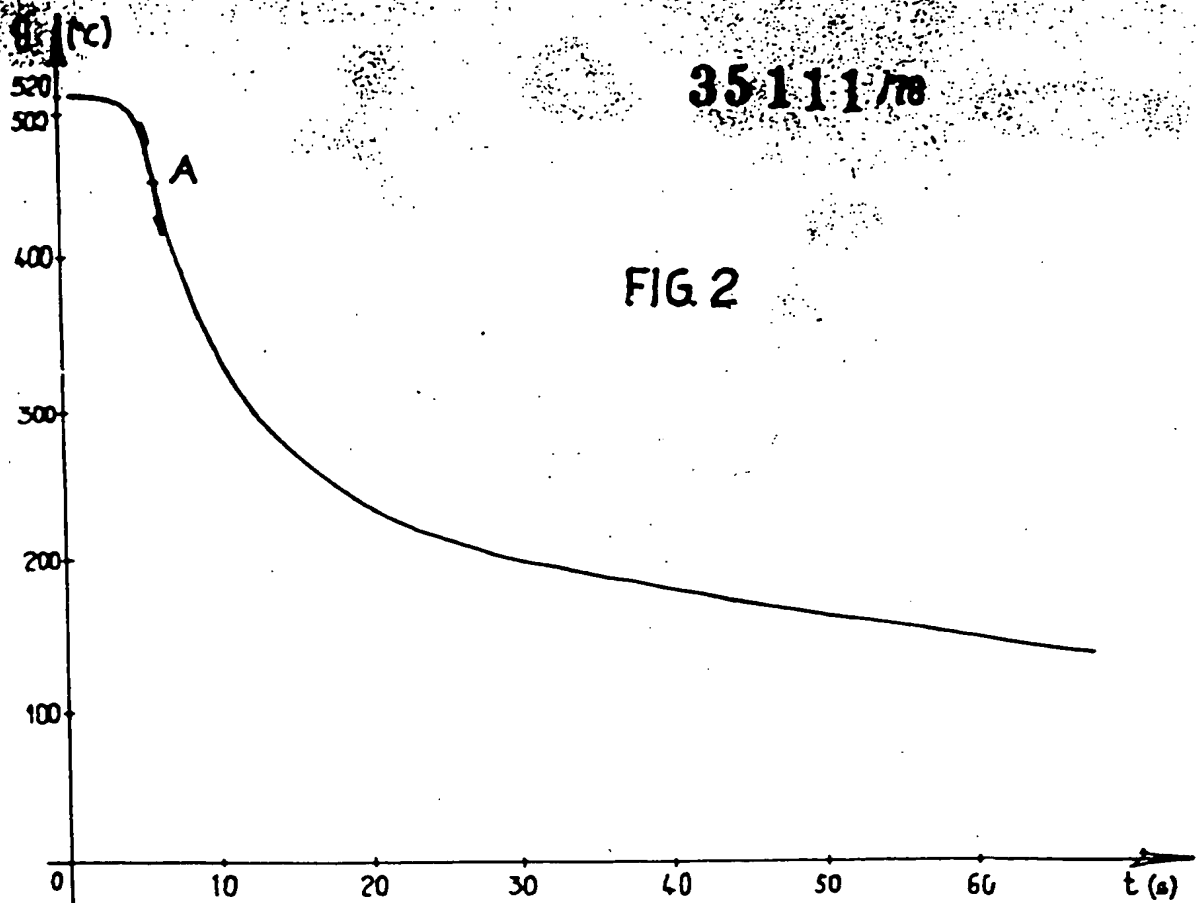


FIG. 1

